WINTER – 2022 EXAMINATION

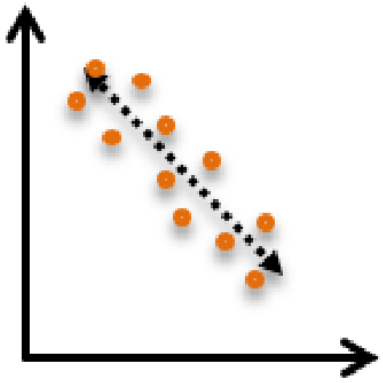
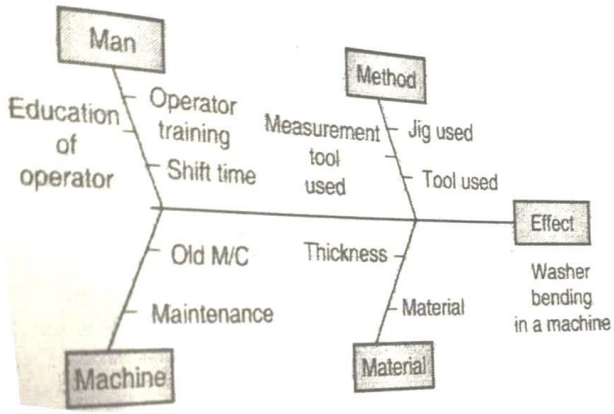
Model Answer

Subject Name: Industrial Engg. & Quality Control **Subject Code:** 22657

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.
8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

Q. No.	Sub Q. N.	Answer	Marking Scheme
Que.1		**Attempt any FIVE of the following**	**10 Marks**
	a)	**Define work study. Name the various steps involved in it.**	
	Sol.	**Work study:** Work study investigates the work done in an organization and aims at finding the best and the most effective way of utilizing the available resources (Men, material, money and machinery) to achieve best possible quality work which involves least possible time and causes least possible fatigue to the worker. Or Work study is a term used to embrace the techniques of method study and work measurement, which are employed to ensure the best possible use of human and material resources in carrying out a specified activity. **Steps:** 1. Select the task to be studied. 2. Record the facts 3. Examine / analyze the facts 4. Develop new method/ measure the task 5. Install new method / compile standard time 6. Maintain new method.	01 Mark 01 Mark

Q. No.	Sub Q. N.	Answer	Marking Scheme
	b)	**State the important functions of process Engineering.**	
	Sol.	(i) Selection of machines (ii) Determining sequence of operation (iii) Combining operations wherever possible (iv) Specifying inspection stages (v) Specifying tools, jigs, fixtures required for process.	½ mark for each function
	c)	**Draw a scatter diagram showing negative correlation between two variables.**	
	Sol.		02 Mark for diagram
	d)	**Name the various control charts used in Statistical Quality Control.**	
	Sol.	$\bar{x}$ - R chart $\bar{x}$ - σ chart C – chart P – chart	½ mark for each
	e)	**With the help of block diagram show the basic structure of cause and effect diagram.**	
	Sol.		02 Mark

Q. No.	Sub Q. N.	Answer	Marking Scheme
	f)	**List out the various factors affecting quality of product.**	
	Sol.	1. Raw material used. 2. Skill of operator. 3. Environmental conditions 4. Machines used for production. 5. Calibration of instruments. 6. Proper methods of using an instrument.	½ mark for each
	g)	**Why 100% inspection is generally not preferred in the industry for mass production.**	
	Sol.	1. Cost required is more for 100% inspection. 2. Time consuming process. 3. Fatigue to the operator. 4. More staff is required for inspection. 5. More material handling so more chances of material damage.	½ mark for each
Q.2		**Attempt any <u>THREE</u> of the following:**	**12 Marks**
	a)	**Explain in brief different "Recording Techniques" used in method study.**	
	Sol.	The success of procedure depends upon the accuracy with which the facts are recorded because they will provide the basis of both the critical examination and the development of the improved method. All the facts relating to selected jobs are recorded in forms, charts and diagrams. (a) Charts: Indicating process sequence (i) Outline process chart (Records only main events) (ii) Flow process chart (Records all events) 1. Man Type 2. Material type 3.Machine / Equipment type (b) Charts: Using a time scale (i) Multiple activity chart (ii) SIMO Chart (c) Models and diagrams: Indicating movements (i) Flow diagram (ii) String diagram (iii) Cycle graph (iv) Chrono cycle graph (v) Two-three dimentional models	01 Mark 01 Mark 01 Mark 01 Mark

Q. No.	Sub Q. N.	Answer	Marking Scheme
	b)	**Explain "Part Print Analysis'. Which information does the process Engineer seeks from it.**	
	Sol.	Preliminary part print analysis is the first step in process planning. The product design is conveyed by design department to process engineer in the form of part print. It is also called as part drawings or blue prints. The part drawing consists of a variety of information which helps in planning the process. The detailed study or interpretation of part drawing under consideration for the manufacturing of the part is called as part print analysis. Part print consists of following information: • Part geometry • Dimensions and associated tolerances • Geometrical tolerances • Surface finish specifications • Material specifications • Quantity of parts required Preliminary analysis is done in order to get a general visualization of the complete manufacturing of the part. **General characteristics of the workpiece** The process engineering department tries to determine following requirements from the detailed study of part print. These are: 1. The general description of the part. 2. The general configuration of part. 3. The material from which the part is made. 4. Originating operation of part. 5. Recording of changes in design. 6. Protection of workpiece during manufacture. **Working drawing:** • Working drawing is referred to all those drawings are reference drawings from which, the parts are manufactured. • These drawings includes part drawings of individual component and sub assembly drawing and final assembly drawing • Working drawing consists of conventions of process, tolerances, surface finish, machining symbols etc. • Working drawings are also referred as production drawings. The drawings represent details of product, its size, shape, material, processes, and tools equipment. • The operator is completely guided by the working drawings during the manufacturing of the product. These are the legal and authentic documents of the company.	01 Mark 01 Mark 01 Mark 01 Mark

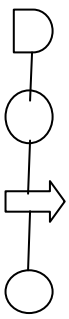
Q. No.	Sub Q. N.	Answer	Marking Scheme
	c)	**With the help of a block diagram show the sequence of activities for any quality characteristics.**	
	Sol.	**Quality Characteristics:** • For the refrigerator, it is described by using colour of body, capacity of the refrigerator, brand of the compressor, warranty, service conditions, etc. These are called as 'quality characteristics'. • The quality characteristics are grouped as: a) Structural type: Length, height, diameter, viscosity, etc. b) Look type: Test, colour, texture, appearance, etc. c) Time oriented: Safety, reliability, service, failures, etc. d) Commercial Cost, discount, warranty, packing, etc. • If also above conditions are applicable for the 'quality of product', similar characteristics are used for 'quality of service". • For service sectors like banking, postal services, transportation, bus services, hospital services, etc. In these all above service characteristics are also used • In banking : satisfaction of consumers, transaction accuracy, prompt time to time service, telephonic internet banking, clarity in transaction space – infrastructure of bank, ATM services, opening hours of banks, interest/loan facility, reliability i.e. accuracy of services, image, honesty, responsiveness of bank, etc.	01 Mark 01 Mark 01 Mark 01 Mark
	d)	**What is the effect of various environment factors such as temperature, noise, light on the efficiency of operator.**	
	Sol.	**Environment factors:** Working conditions are those which surround the worker as he performs his task. Working conditions affect his physical well-being and therefore his efficiency towards work. Some of the working conditions are mentioned below. **1. Temperature:** It includes the temperature, humidity and air flow. Poor heat and humid conditions produce thermal stresses in the worker which affect their efficiency, concentration and dexterity of their members of body. Working temperature of 60-65 ^{0}F is considered as normal but it varies according to nature of work. Humidity and heat are related to each other both affect comfort and tolerance of the body to heat. The effect of heat can be minimized by shielding isolating best sources, by installing and providing local ventilation by permitting breaks or rest pauses in cool or extreme hot conditions.	01 Mark 01 Mark

Q. No.	Sub Q. N.	Answer	Marking Scheme
		2. Noise: Noise is defined as unwanted sound and it has been shown to have both short and long term effects on performance. Noise is the cause of various problems like fatigue, imitation, reduced productivity and accidents. To reduce the noise: 1. Control the noise at source. 2. By proper machine lubrication maintenance, padding and by providing noise mufflers 3. Using noise absorbers 4. Provision of ear plugs S. Improved workplace layout. **3. Light** Most of the time man depends upon sunlight as a natural source of light. But sometimes of weather conditions and in nights. When shop activities are carried out indoors or at night, it is necessary to provide artificial light. Visibility depends on size and colour of product, its distance from eyes, intensity of light, contest of colour these factors must be studied precisely in case of accurate works, work in dangerous environment or in case of poor working conditions. The lighting system should provide: 1. Sufficient brightness 2. Uniform illumination 3. A contrast between brightness of the job and of background 4. No direct or reflected glare	01 Mark 01 Mark
Que.3		**Attempt any <u>THREE</u> of the following**	**12 Marks**
	a)	**Define process chart, draw the various symbols used in process chart.**	
	Sol.	A chart representing process is called process chart	

Q. No.	Sub Q. N.	Answer	Marking Scheme
			01+03 Mark

Event	Symbols
Operation	
Storage	
Delay or Temporary storage	
Transport	
Inspection	
Operation cum –transportation	
Inspection cum –operation	

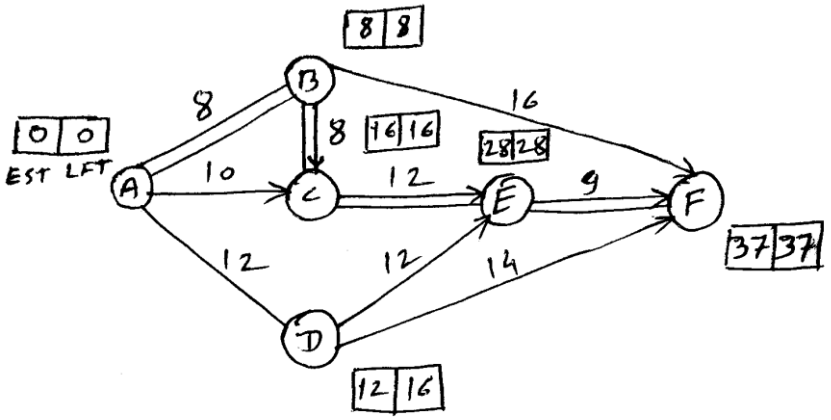
	b)	**Define anthropometry and explain its importance.**	
	Sol.	Anthropometry is defined as , " the branch of ergonomics, which deals with shape and size of body". Anthropometry is defined as "The scientific study of measurement and proportions of the human body, which involves the systematic measurement of dimensional description of size and shape of human body". Anthropometry play an important role in industrial design , clothing design , ergonomics and architecture , where statistical data about the distribution of body dimensions in the population are used to optimize products.	02+02 Mark
	c)	**Draw a two handed process chart to assemble a nut and bolt.**	
	Sol.		03+01 Marks

Job: Assemble a nut and bolt			
Left hand	Symbols L. S.	Symbols R. H.	Right hand
Pick up bolt			Idle
Hold			Pick up nut
Hold			To left hand
Hold			Assemble (Screw up)

<table>
<tr><th>Q. No.</th><th>Sub Q. N.</th><th>Answer</th><th>Marking Scheme</th></tr>
<tr><td></td><td></td><td>Summary
<table>
<tr><th colspan="2">Lift hand</th><th colspan="2">Right hand</th></tr>
<tr><td>  </td><td>01</td><td>  </td><td>02</td></tr>
<tr><td>  </td><td>03</td><td>  </td><td>00</td></tr>
<tr><td>  </td><td>00</td><td>  </td><td>01</td></tr>
<tr><td>  </td><td>00</td><td>  </td><td>01</td></tr>
</table></td><td></td></tr>
<tr><td></td><td>d)</td><td>Classify the man – machine system</td><td></td></tr>
<tr><td></td><td>Sol.</td><td>a) Based on the importance of feedback
- Open loop system
- Closed loop system
b) Based on the type of processing
- Manual Systems
- Semi- automatic Systems
- Automatic Systems
c) Based on the number of men and machines
- One to one Man – Machine System
- Many to one type Man- Machine System
- One to many Man - Machine System
- Many to many Man – Machine system</td><td>04 Mark</td></tr>
<tr><td>Que.4</td><td></td><td>Attempt any <u>THREE</u> of the following</td><td>12 Marks</td></tr>
<tr><td></td><td>a)</td><td>State any four advantages of Ergonomics (any 4)</td><td></td></tr>
<tr><td></td><td>Sol.</td><td>1. Higher productivity
2. More the human comfort, less the fatigue to operator.
3. Better deign to machine.
4. Increase the safety.
5. Better integration of man –machine system.
6. Reduced labour turnover</td><td>01 Mark for each</td></tr>
</table>

Q. No.	Sub Q. N.	Answer	Marking Scheme
	b)	**Describe any two of the following in connecter with a man – machine system** **i) Design of visual display** **ii) Design of control** iii) **Design of workplace**	
	Sol.	**Design of visual display** - Display are the device, through which, the man can receive the information from the machine. - A good display is one, which allows proper combination of speed, accuracy and sensitivity of display. - Display provides primary and secondary information needed by operators in making decisions and in effecting control responses. - Information presented by display can be considered as dynamic or static - Two broad categories of display are 1. Visual display 2. Auditory display - Depending upon the type of information provided by visual display, Visual display can be further classified into two subgroups. i) Qualitative display – Indicating only the condition or state without giving any values. ii) Quantitative Displays- Give numerical information about the equipment or machine Auditory display can make monitoring performance superior **Design of control** A control is a device which can transmit information to some machine, mechanism or a system. Thus a control is selected based upon the nature of information desired to be transmitted. The performance efficiency of a human operator is affected by the nature/type of controls provided with any machine. A proper design goes a long way in making the work of operator easy. A proper control for any machine should be the optimum for the machine. Factor Affecting the Selection of a Control Device: 1. Operational Functions of the Control 2. Need of control task. 3. Informational Need of operator 4. Space and layout requirement	Any two 02+02

<table>
<tr><th>Q. No.</th><th>Sub Q. N.</th><th>Answer</th><th>Marking Scheme</th></tr>
<tr><td></td><td></td><td>Design of workplace
Working environment is another very important factor which requires consideration in the design of man-machine systems.
The environment in which a worker/operator performs his job has a big influence on the following:
(i) The fatigue or the strain a worker acquires in performing his task.
(ii) The productivity of the system.
Even the optimum work methods would not help if the workplace layout or the working environment where the operator work has.
Unbearable noise.
Insufficient light leading to poor visibility ‘smoke and fumes, and uncleanness etc.
Thus an operator’s performance and comport are dependent upon proper design of work space. Our aim is to arrive at optimum location and arrangement of each component essential for smooth working.
These components affecting workers task may be as follows:
1. Equipment’s.
2. Seating arrangement.
3. Displays.
4. Controls.
5. Materials.
6. Working space.</td><td></td></tr>
<tr><td></td><td>c)</td><td>Enlist the benefits of kaizen.</td><td></td></tr>
<tr><td></td><td>Sol.</td><td>Benefits of kaizen
1. Increased Productivity
2. Improve Quality
3. Reduced Cost
4. Faster Deliveries
5. Improve Safety
6. Process standardization
7. Waste reduction</td><td>Any Four 01 Mark for each</td></tr>
<tr><td></td><td>d)</td><td>What is meant by “5S” Explain each “S” in detail.</td><td></td></tr>
<tr><td></td><td>Sol.</td><td>
<table>
<tr><th>Japanese term</th><th>English</th><th>Explanation</th></tr>
<tr><td>1.Seiri (tidiness)</td><td>Sort</td><td>Remove unnecessary items from each area</td></tr>
<tr><td>2.Seiton (orderliness)</td><td>Set In Order</td><td>Organize and identify storage for efficient use</td></tr>
<tr><td>3.Seiso (cleanliness)</td><td>Shine</td><td>Clean and inspect each area regularly</td></tr>
<tr><td>4.Seiketsu (standardization)</td><td>Standardize</td><td>Incorporate 5S into standard operating procedures</td></tr>
<tr><td>5.Shitsuke (discipline)</td><td>Sustain</td><td>Assign responsibility, track progress, and continue the cycle</td></tr>
</table>
</td><td>04 Mark</td></tr>
</table>

Q. No.	Sub Q. N.	Answer	Marking Scheme
Que.5		**Attempt any TWO of the following**	**12 Marks**
	a)	**Critical Path**  Forward Pass → Max. Backward Pass → Min. Critical Path (C.P.) = A 8 B 8 C 12 E 9 F	Network Diag. 4m C.P. 2m
	b)	**Task**- Replacement of punctured tyre. **Chart begins**- Jack up the car. **Chart ends**- Remove the jack. **Checked by**- Mr. ABC **Date of charting**- DD/MM/YYYY 1 Jack up the car. 2 Remove all nuts of a wheel. 3 Remove the old/punctured wheel/tyre. 4 Fit the new wheel/tyre. 5 Fit all the nuts. 6 Tighten all the nuts by spanner. 7 Check the tyre pressure & movement. 8 Remove the jack. Summery Symbol | Freq. ○ | 07 □ | 01	6 Mark

Q. No.	Sub Q. N.	Answer	Marking Scheme
	c)	Given: $\Sigma X = 357.50$, $\Sigma R = 9.90$, Number of Subgroups = $N = 20$; $A_2 = 0.18$, $D_3 = 0.41$, $D_4 = 1.59$, $d_2 = 3.725$	
		Calculating Grand Average ($\bar{\bar{X}}$) and Average Range $\bar{R}$.	01 Mark
		i.] $\bar{\bar{X}} = \frac{\Sigma X}{N} = \frac{357.50}{20} = 17.875$.	
		ii.] $\bar{R} = \frac{\Sigma R}{N} = \frac{9.90}{20} = 0.495$	
		① Control Limits of $\bar{X}$ Chart:-	02 Mark
		i.] UCL $\bar{X} = \bar{\bar{X}} + A_2 \cdot \bar{R} = 17.875 + (0.18 \times 0.495) = 17.964$	
		ii.] LCL $\bar{X} = \bar{\bar{X}} - A_2 \cdot \bar{R} = 17.875 - (0.18 \times 0.495) = 17.786$	
		∴ UCL $\bar{X}$ = 17.964	
		∴ LCL $\bar{X}$ = 17.786	
		② Control Limits of R Chart:-	02 Mark
		i.] UCL R = $D_4 \times \bar{R} = 1.59 \times 0.495 = 0.78705$	
		ii.] LCL R = $D_3 \times \bar{R} = 0.41 \times 0.495 = 0.20295$	
		∴ UCL R = 0.78705 ∴ LCL R = 0.20295	
		③ Finding Process Capability:-	01 Mark
		Process Capability = $6\sigma' = 6\frac{\bar{R}}{d_2} = 6 \times \left(\frac{0.495}{3.725}\right) = 0.797$	
		∴ Process Capability ($6\sigma'$) = 0.797	

Q. No.	Sub Q. N.	Answer	Marking Scheme
Que.6		**Attempt any TWO of the following**	**12 Marks**
	a)	**Objectives of Line Balancing** (six objectives for 6 marks) 1. To equalize the workload among the workers Workload should be distributed equally at each stage of assembly line wrt overall assembly time. 2. To identify the bottleneck operation Identify the bottleneck operation and improve the stage by doing some modifications or corrections. 3. To eatablish the speed of production line To divide the work properly wrt worker's movements. Sometime, combine the operations for improvement the speed of production line. 4. To deterine the number of workstations. Industrial Engineer should do the time study of each stage and as per sequence of assembly determine the number of workstations for completing all assembly operations. 5. To determine the percentage worklod of each operator Workload at each stage should be distributed equally in terms of percentage too. 6. To assist in plant layout Line balancing can be done in such a way that it should utilize the minimum space in a factory. Therefore, space saving can be possible and effective plant layout should be possible	01 Mark for each
	b)	Given:-	

Assembly No.	1	2	3	4	5	6	7	8	9	10
No. of Defects.	2	3	2	5	2	3	5	3	0	1

For 'c' Chart

we have,

1.] Central line = $\bar{C}$ = $\frac{\text{Number of Defects in all Assemblies}}{\text{Total Number of Assembly.}}$

$= \frac{2+3+2+5+2+3+5+3+0+1}{10}$

$= \frac{26}{10} = 2.6.$ $\therefore \bar{C} = 2.6$ — 01 Mark

2.] Control Limits for 'C' Chart :-

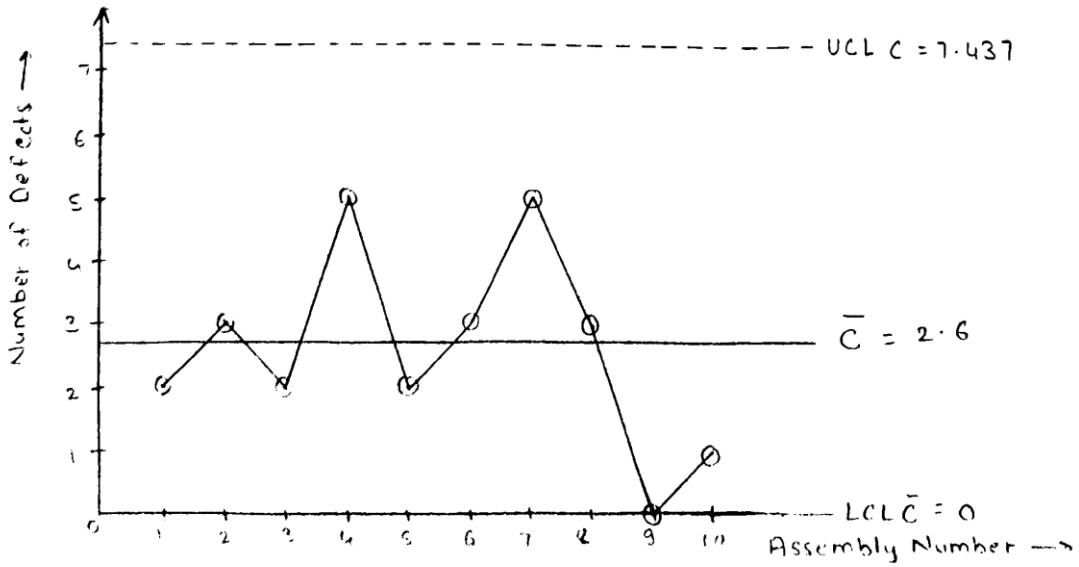
UCL $c = \bar{c} + 3\sqrt{\bar{c}} = 2.6 + 3\sqrt{2.6} = 7.437$

LCL $c = \bar{c} - 3\sqrt{\bar{c}} = 2.6 - 3\sqrt{2.6} = -2.23 \cong 0$ — 02 Mark

$\therefore$ UCL $c = 7.437$ $\therefore$ LCL $c = 0$

Q. No.	Sub Q. N.	Answer	Marking Scheme

3] Construction of 'C' Chart



02 Mark

4] Conclusion :- As all the points lie between the control limits, Hence, Process is in Control.

01 Mark

c) Machine- A

Given : Sample Size (n) = 200
No. of Sample = 10

* Procedure for Plotting P Chart :-

(1) Calculate fraction defective of each sample :-

For first sample, $p = \frac{\text{Number of defective}}{n} = \frac{25}{200} = 0.125$

Accordingly, we get

Sample No.	1	2	3	4	5	6	7	8	9	10
Defectives	25	28	30	30	20	29	31	26	31	27
Fractional Defective	0.125	0.14	0.15	0.15	0.1	0.145	0.155	0.13	0.155	0.135

(2) Central Line of P- Chart :- (Average Fractional Defective.)

$$\bar{P} = \frac{\text{Total No. of defectives in all Sample}}{\text{Total No. of Components inspected}} = \frac{[25+28+30+30+20+29+31+26+31+27]}{10 \times 200}$$

$$\therefore \bar{P} = 0.1385$$

01 Mark

Q. No.	Sub Q. N.	Answer	Marking Scheme

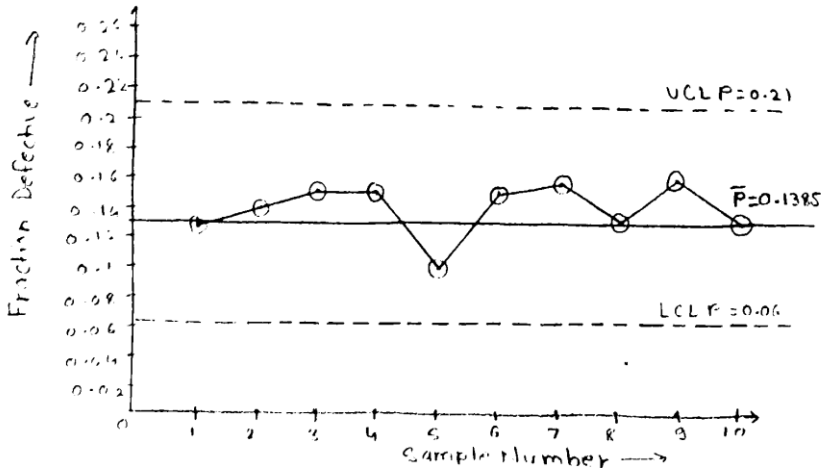
③ Control Limits for P Chart :-

i.] $UCL\ P = \bar{P} + 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}} = 0.1385 + 3\sqrt{\frac{0.1385\,(1-0.1385)}{200}} = 0.21$

ii.] $LCL\ P = \bar{P} - 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}} = 0.1385 - 3\sqrt{\frac{0.1385\,(1-0.1385)}{200}} = 0.065$

01 Mark

④ Construction of P Chart.



Conclusion :-
As all the point lie between the control limits, the process is in control.

01 Mark

Machine- B

Similarly, for machine B Sample size (n) = 200
No. of Sample = 10

Sample No.	1	2	3	4	5	6	7	8	9	10
Defectives	11	08	22	15	12	27	10	15	10	02
Fractional Defective	0.055	0.04	0.11	0.075	0.06	0.135	0.05	0.075	0.05	0.01

i] Central line of P-Chart :-

$$\bar{P} = \frac{\text{Total Number of Defective in all Sample}}{\text{Total Number of Component inspected.}} = \frac{[11+08+22+15+12+27+10+15+10+02]}{10 \times 200}$$

$$\therefore \bar{P} = 0.066$$

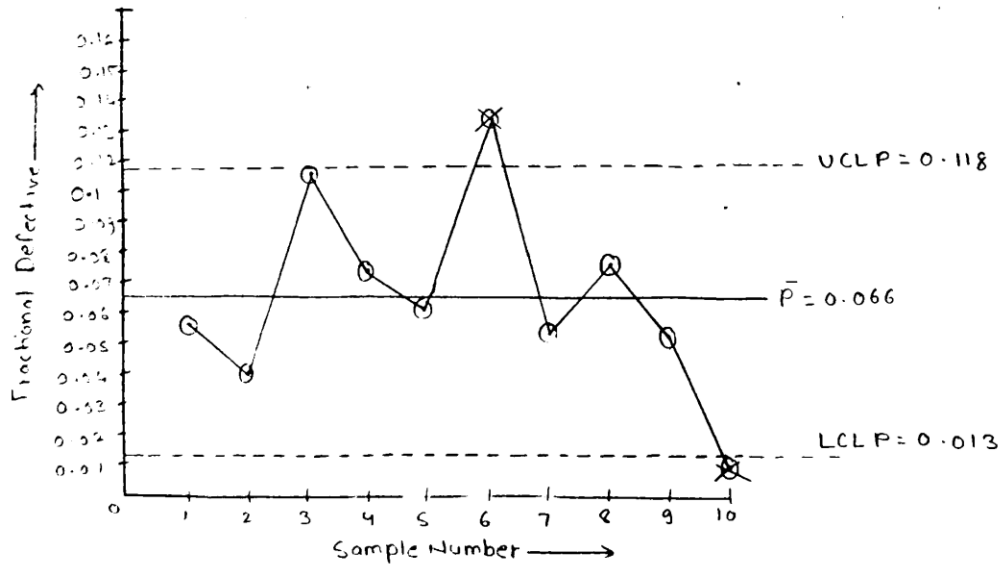
01 Mark

ii.] Control limits for P Chart :-

1) $UCL\ P = \bar{P} + 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}} = 0.066 + 3\sqrt{\frac{0.066\,(1-0.066)}{200}} = 0.118$

2) $LCL\ P = \bar{P} - 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}} = 0.066 - 3\sqrt{\frac{0.066\,(1-0.066)}{200}} = 0.013$

01 Mark

Q. No.	Sub Q. N.	Answer	Marking Scheme
		iii.] Construction of P-Chart:-  iv.] Conclusion:- As point (6) and (10) is lying out of control limits, the process is out of control.	01 Mark